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INTERNATIONAL BULLETIN
OF PLANT PROTECTION

1945 Nos. 1 & 2

AIR TRANSPORT AND PHYTOSANITARY CONTROL*

There is not the slightest doubt that the protection of our crops is also suffering the consequences of war.

The rarefaction, not to say the complete want of parasiticides of recognized efficacy and of current use ; the difficulty of procuring new apparatus for treatments and sometimes also the impossibility of finding on the market spare parts to restore to working order some of the implements long out of use ; the scarcity or inexperience of the workers left after the call to arms of the valid and expert elements ; shortage of transport : all contribute towards promoting the spread of plant diseases and pests.

It is not impossible that in addition to the only slightly or not at all satisfactory results obtained in the control of the different noxious agents, due to the inadequacy, inefficacity or irrational application of the means available, there are still other dangers when a war flares from country to country, from continent to continent.

In such a situation, the transport from one end of the world to another of foodstuffs and agricultural raw material, as also of commodities in general, loading and unloading operations proceed irregularly, frequently in a disorganized manner and sometimes even under cover of night because of possible ambush by the enemy. Because of the want of competent personnel on the spot or other material obstacles of the moment, these operations cannot always be effected by rigorously observing the rules which regulate the traffic of these products in time of peace.

Now, it is precisely during these international and inter-continental exchanges effected under the pressure of events and often in the enervation caused by the dangers and anxiety in consequence of the war in course, that a crop parasite, new for a certain country if not for science, may escape more easily than in normal times phytosanitary control and thus become introduced into a new environment, breed without hindrance at first, suddenly reveal itself as a dangerous adversary of the agricultural prosperity of the region where it has succeeded in establishing itself and at the same time constitute a serious menace to the crops of the neighbouring zones.

An example ?

* Note of GIULIO TRINCHIERI, International Institute of Agriculture.

Many investigators consider that the introduction of the Colorado potato beetle (*Leptinotarsa decemlineata* Say) into France is a consequence of the first world war

When the presence of this dangerous insect was observed in the Department of Gironde in mid June, 1922, it already occupied an area of at least 250 sq. km.

Many suppositions were raised to explain the origin of the Gironde invasion but, according to FEYTAUD (*3*), it is more probable than transport [of the insect] was accidentally made with one of the multiple commodities passed from America to Europe during the war.

What followed is particularly instructive from the practical standpoint. It may be said that since that period the Colorado beetle opened the way to the invasion of Europe.

In effect, now established on this side of the Ocean, it began to extend indefinitely its area of distribution.

In brief, in 1931, already thirty of the French Departments proved to have scattered foci of this beetle. The following year, the departments contaminated increased to thirty-seven and in 1933 to forty, namely, practically half of France During 1934, attack became general in fifteen departments. In 1935, the presence of the Colorado beetle was observed, *inter alia*, in four hundred and thirty-six communes of the Seine-et-Marne Department and in five hundred and forty-one in the Marne Department. During the first four months of 1937, there were eighty-five Departments contaminated of which forty-one were completely invaded At this period, therefore, there remained only five Departments of continental France which were still free from this scourge. In 1940, only the Maritime Alps were considered safe.

During this time, the countries more or less close to France were not protected from the Colorado beetle danger : in reality, invasion gradually spread into Belgium, Luxemburg, Germany, Holland, Switzerland and into Spain, not counting the sporadic appearances of the beetle in England and in Normandy Isles.

Another example.

It was also during the first world war, as is indicated in the manual drawn up by the personnel of the Royal Station of Agricultural Entomology at Florence (*18*), that potatoes from abroad and affected by another formidable pest, the potato tuber moth (*Phthorimaea operculella* Zell.), arrived in an Italian port.

Still another example.

Also during this same war, according to MALENOTTI (*12*), the Argentine ant (*Iridomyrmex humilis* Mayr) arrived in Italy very probably from France to where it must have been carried in the cases of biscuit intended for the soldiers and dispatched from the United States of America.

What surprises of this kind will the present war reserve for one or the other of the belligerent countries ?

In truth, the state of war may only constitute a temporary aggravating circumstance of a fact which is in itself capable of occurring at any moment and in any part of the world.

Despite this, its practical importance is not realized by the majority and lost sight of by others in everyday routine.

Thus when we utilize or when we see being employed one of the different means of transport of which man disposes to meet his personal requirements or to establish and maintain economic and social relations with the outside world, we do not think that the railway, animal drawn vehicles and motor-cars, boats, sailing-vessels and steamers count among the very numerous factors — and not the least important — which govern the spread of plant and animal species injurious to man, livestock and agriculture.

Thus also the man in the street, any townsman who walks through a vine plot infected by phylloxera (*Phylloxera vitifoliae* Fitch) to pass into another plot still untouched, certainly does not imagine that perhaps it is he who will transport by means of his shoes this serious pest into the still healthy vineyard.

Yet, it is precisely by means of transport that the Colorado beetle, the Argentine ant and vine phylloxera just mentioned passed from America to Europe; and like them, also the potato blight (*Phytophthora infestans* (Mont.) de Bary), powdery mildew (*Uncinula necator* (Schw.) Burr.), downy mildew (*Plasmopara viticola* (Berk. et Curt.) Berl. et De Toni) and the black rot (*Guignardia bidwellii* (Ellis) Viala et Ravaz) of the grape vine, American mildew of gooseberry (*Sphaerotheca mors-uvae* (Schw.) Berk.), etc. Reciprocally, in the same way have passed from Europe to America the wart disease of the potato (*Synchytrium endobioticum* (Schilb.) Perc.), white pine blister rust (*Cronartium ribicola* J. C. Fisher), European larch canker (*Dasyscypha willkommii* (Hart.) Rehm), elm disease (*Ophiostoma ulmi* (Schwarz) Nannf.), small cabbage butterfly (*Pieris rapae* L.), asparagus beetle (*Crioceris asparagi* L.) and the European corn borer (*Pyrausta nubilalis* Hbn.) to cite but a few. We will also ignore the numerous exchanges of this nature which concern other parts of the globe.

* * *

Naturally, nor is the most modern means of transport known today, namely air transport, any exception to the common rule

On the contrary, because of its special characteristic, that is, its greater speed, which makes it possible to cover enormous distances within a relatively short time, aircraft, of whatever type, seem especially designed to play the role just indicated. *

The present conditions seem to be very propitious.

In fact, think of the enormous and unbelievable development air transport has attained and continues to undergo owing to the war in all parts of the globe.

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* Chance so ordains that the same aerial means also plays quite a different role in the same phytosanitary sphere and in that of public health. We allude to the assistance airplanes render to man in the destruction of certain ravagers of herbaceous crops, fruit trees and forest species, and in the control of anopheles vectors of malaria, etc. See, *inter alia*, the bibliographical index drawn up by McBath (*11*) and the very recent review of the data on this question effected by Voelkel (*25*).

Henceforth it is no longer a question of a small number of planes, but of thousands and thousands of units which, departing from the most diverse bases, daily streak through the sky in all directions, with an effective load of thousands and thousands of tons, making two-way flights thousands and thousands of kilometres long. The load they carry is not always composed of men, arms and munitions, but frequently also of supplies of another nature, including also large quantities of foodstuffs of every kind.

The cessation of hostilities will not fundamentally modify this state of affairs.

Nothing extraordinary is prophesized in saying now that when the war is over, aerial movement will not cease.

As soon as peace is signed, every people will feel the urgent need to establish relations with the rest of the world. This will be a necessity, not only political, but also moral and social and particularly economic. The countries convulsed by the torment of the war will desire to renew as soon as possible the normal course of their trade, in order to ensure their existence and hasten the work of adjustment and home reconstruction. A certain time, however, will elapse before land transport by rail or by road, as also by water, maritime or river, begin to function everywhere in full swing, owing to the damage caused by the war to railway lines, roads, bridges and ports, and also to the destruction of such a large percentage of rolling stock and merchant ships.

Alone, amidst such a situation, air transport will be in a condition from one moment to another to compensate for the inadequate railways and merchant marine. Through their speed, air transport carriers will hasten the return of all countries into the wide stream of international life. There is nothing extraordinary, therefore, in thinking that at the end of the present world war, and also subsequently, for the transport of goods and passengers over long distances, recourse will be had immediately and mainly to the use of civilian and commercial aviation. The latter could utilize, while awaiting the construction of new planes designed especially for that usage, the military planes, rapidly transformed into instruments of peace and welfare.

It follows that, after the war also, air traffic between the states and continents will be very intense. Employed largely as a means of transport, particularly for certain foodstuffs and agricultural raw materials, it will be able and perhaps even more so than in the past, to assist in spreading crop parasites throughout the world.

* * *

That this contingency may become fact and to what extent can be judged from the results of the observations and investigations effected on this subject.

In April, 1928, as corroboration of a note on plant quarantine and inspection, MONTGOMERY (*13*) reproduced, *inter alia*, a photograph showing the landing at Key West, Florida of passengers from a sea-plane arrived from Cuba. Among these, there was a woman carrying a bunch of flowers in her hand, and the key to the figure states that the inspectors in charge of phytosanitary control frequently found that flowers brought in from outside harboured the citrus white-fly (*Aleurocanthus*

woglumi Ashby) already recognized at that time as very injurious to citrus species in the Bahamas and in the environs of Havana.

On October 15 of the same year, the first foreign commercial passenger and cargo-carrying dirigible, the ' Graf Zeppelin ', arrived from Germany at the United States of America.

The fresh provisions on board such as fruit and vegetables had been consumed before arrival at Lakehurst, (New Jersey); neither living plants nor plant products in general were contained in the load of the airship nor in the baggage of the passengers. Three of these latter, however, each brought from the departure point a bunch of flowers, the first carnations, the second crysanthemums and the third roses. On inspection, states KISLIUK (*8*), these flowers revealed the presence of the following plant and animal organisms: — *Heterosporium echinulatum* (Berk). Cooke [*Didymellina dianthi* C. C. Burt], causal agent of carnation ring spot ; leaf spot due perhaps to *Septoria chrysanthemi* Cav. [*S. chrysanthemella* Sacc.], which is the cause of chrysanthemum blotch ; *Sphaceloma rosarum* (Passer.) Jenk., cansal agent of rose leaf spot ; green peach aphis (*Myzus persicae* Sulz.) ; lettuce aphis (*Tritogenaphis* [*Macrosiphum*] *sonchi* L.) ; an undetermined aphid ; a scale insect, perhaps *Lecanium corni* Bouché or plum scale ; tobacco or onion thrips (*Thrips tabaci* Lind.) ; rose leafhopper (*Typhlocyba rosae* L.) ; Noctuid eggs and a Noctuid cocoon, and finally an undetermined spider.

FLEURY (*4*) reported that tufts of hay caught in the tail gear of an airplane arrived in 1929 at San Diego, California from Sonora, Mexico were infested with the eelworm *Tylenchus angustus* Butler [*Anguillulina angusta* (Butler) Goodey]. The same author (*5*) also relates that in a tuft of hay taken in 1930 from the running gear of another plane also from Mexico the same nematode, new to the United States was present. This eelworm is the causal agent of a rice disease known under the name ' Ufra ' in Bengal, India, and was successively indicated as a parasite of the same cereal also in Malaya.

The list of plant pests intercepted at the time of their arrival in the U. S. A. which the Department of Agriculture, Washington publishes periodically furnishes many other examples.

On August 4, 1929, on bunches of flowers transported on board the 'Graf Zeppelin', the following Thysanoptera not known to occur in the United States, were found: — *Frankliniella intonsa* Tryb. on *Aster, Dahlia, Gaillardia grandiflora, Lychnis* and *Antirrhinum* ; *Fr. intonsa* f. *adusta* and *Haplothrips aculeatus* F. on *Antirrhinum*; *Taeniothrips atratus* (Hal.) on *Aster, Dianthus, G. grandiflora, Gladiolus, Lychnis* and *Antirrhinum* ; *Thrips flavus* Schrk. on *Antirrhinum* ; *Thr. fuscipennis* Hal. on *Aster, Dahlia, G. grandiflora, Lychnis* and *Antirrhinum* ; *Thr. fuscipennis* f. *corticina* and *Thr. validus* on *Dianthus* and *Antirrhinum.* Together with the above-mentioned Thysanoptera found in the bunches of flowers were also other insects such as the Noctuid *Phytometra* [*Plusia*] *gamma* L. on *Aster* and *Antirrhinum* ; the scale insect *Saissetia hemisphaerica* (Targ.) on *Dianthus* ; *Agromyza* sp. on *Lychnis* ; *Coleophora* sp. and *Tritogenaphis* [*Macrosiphum*] sp. on *Aster*; a geometrid on *Dahlia* and *Antirrhinum* ; a mirid on *Dianthus, Gladiolus* and *An-*

irrhinum; a pterophorid on *Antirrhinum,* and a syrphid on *Aster* and *Antirrhinum.* Other airplane interceptions reported the same year, 1929, the presence of the pink cotton bollworm (*Pectinophora* [*Platyedra*] *gossypiella* Saund.) in a sample of cotton from Mexico ; green coffee scale (*Coccus viridis* Green) on *Gardenia florida* and *Gardenia* sp. from Cuba ; citrus mussel scale (*Lepidosaphes beckii* Newm.) on *Citrus sinensis* from Mexico ; *L. beckii* and rufous scale (*Pseudaonidia* [*Selenaspidus*] *articulatus* Morg.) on *C. grandis* from Honduras ; olive scale (*Saissetia oleae* (Bern.)) on *G. florida* from Cuba (*21*).

This same official North American publication registered for the period from July 1, 1931 to June 30, 1932, the interception of *Asterina* sp. and *Phoma* sp. on orchids from the Panama Canal Zone ; the causal agent of citrus scab(*Sphaceloma fawcettii* Jenkins) on *Citrus nobilis* var. *deliciosa* from Cuba ; the citrus white-fly (*Aleurocanthus woglumi* Ashby) on *Coffea*; *Anastrepha* sp. on mangoes from Jamaica ; the green coffee scale (*Coccus viridis* (Green)) on *Gardenia florida* from Cuba as well as on *Citrus* sp. and *Mentha* sp. from Haiti ; *Frankliniella insularis* Frank. on *Canavalia obtusifolia* and *Borrichia glabrata* from the Bahamas, etc. (*22*).

During the period July 1, 1932 to June 30, 1933, was reported the interception on *Citrus* from Puerto Rico of *Diaporthe citri* (Faw.) Wolf, the perfect stage of *Phomopsis citri* Faw., causal agent of the citrus melanose ; that of the green coffee scale (*Coccus viridis* (Green)) and *Protopulvinaria* [*Pulvinaria*] *pyriformis* Ckll. on *Gardenia florida* from Cuba, etc. (*23*).

Let us run through another list and specifically that covering the period from July 1, 1936 to June 30, 1937. During this period, the following were intercepted : 1799 insects belonging to 325 genera, 53 plant parasites representing 16 different genera ; all were found in, on or with hosts belonging in their turn to 83 genera and derived from 22 different countries.

There were intercepted, *inter alia* : *Alternaria herculea* (Ellis et Mart.) Elliott [*A. brassicae* (Berk.) Bolle] on *Brassica oleracea* ; *Capnodium* sp. and *Cephaleuros virescens* Kunze on *Camellia japonica* ; the causal agent of the rose black spot (*Diplocarpon rosae* Wolf) on *Rosa* sp. ; *Heterosporium echinulatum* (Berk.) Cooke [*Didymellina dianthi* C. C. Burt] on *Dianthus* sp. ; *Macrosporium* sp., *Meliola* sp., *Septobasidium* sp. and *Stilbum* sp. on *Gardenia florida,* all from Mexico ; *Cercospora* sp. on *Dianthus* sp. from Guatemala ; the anthracnose fungus (*Colletotrichum gloeosporioides* Penz.) on *Citrus sineusis* from Haiti ; *Colletotrichum* sp. on *Epidendrum* sp. from Paraguay ; *Diplodia* sp. on *Aleurites triloba* from the Bahamas ; *Phomopsis citri* Faw. on *Citrus aurantium, Phomopsis* sp. on *Jasminum sambac, Septobasidium* sp. on *C. sinensis* and *Sphaceloma fawcettii* on *C. aurantium,* all from Cuba; *Phyllosticta* sp. on *Arachis glabrata* from Brazil ; *Septobasidium* sp. on *C. sinensis* from Jamaica ; the peach and rose mildew (*Sphaerotheca pannosa* (Wallr.) Lév.) on *Rosa* sp. from Germany. And among the animal pests : *Amorbia emigratella* Busk on *Gardenia florida* from Mexico ; the Mexican fruit fly (*Anastrepha ludens* Loew.) in a fruit of *C. sinensis* from Mexico ; *Aspidiotus palmae* Morg. et Ckll. and *A. persearum* on *Camellia* sp. from Mexico ; *A. spinosus* on *Mammea* sp. from Cuba and on *Camellia* sp. from Mexico ; *Chrysomphalus personatus* Comst. on

Camellia sp. and *Rosa* sp. from Mexico ; the green coffee scale (*Coccus viridis* (Green)) on *G. florida* from Cuba and on *Coffea* sp. from Jamaica ; *Frankliniella cephalica* Crawf. on *Rosa* sp. from Colombia ; *Fr. cubensis* Hood on *Rosa* sp. from Cuba ; *Fr. fortissima* on *Gladiolus* sp. from Mexico ; *Limothrips denticornis* Halid. on *Rosa* sp. from Germany ; *Macrosiphum luteum* on orchid from Mexico ; *Selenothrips rubrocinctus* Giard. on *Rosa* sp. from Cuba ; *Taeniothrips atratus* (Hal.) on *Gladiolus* sp. from Germany ; *Taen. ericae* on *Rosa* sp. also from Germany ; *Taen. hawaiiensis* on *Jasminum sambac, Plumeria acutifolia* and *Zingiber* sp. from Hawaii ; the gladiolus thrips (*Taen. simplex*) on *Gladiolus* sp. from Mexico, etc. (*24*).

RYAN (*17*) notes that, especially in the case of airplanes coming from Texas, it was found many times in California, that the osseous and spiny fruits of the zygophyllaceous plant *Tribulus terrestris* L. which is known there — under the common name of puncture vine — as one of the most serious weed pests, were hooked onto the tyres of the wheels of the undercarriage of the plane, as also occurs with automobile tyres, which contributes towards facilitating their spread.

According to the data published in September, 1938 by ROSS (*16*), from May, 1937 to February of the following year, 84 seaplanes arrived at Durban, Union of South Africa. On 28 of these planes, living insects were found, and dead insects on 16. Among the insects which had been transported, there were Diptera, Lepidoptera, Orthoptera, etc.

In 1936, a passenger aeroplane service was established between California and Manila, Philippines calling at Honolulu, Hawaii, Midway Island, Wake Island and Guam. Subsequently the route was extended to Hong Kong. In this respect, PEMBERTON (*14*) informs us that soon inspection of the planes which arrived at the airport near Honolulu amply proved that a real danger menaced the Hawaiian sugar industry, as numerous insects, which the author does not name, were transported in the live state by these planes. This fact prompted the Hawaiian Sugar Planters' Association to take without loss of time opportune protection measures.

Already another indirect source indicated that precisely in a plane of the Trans-Pacific air route, arrived at Hawaii, up to seventy specimens were counted of an injurious rice leafhopper, *Nephotettix* sp., which incidentally can transmit the rice virus disease of dwarfing.

Still at Hawaii, PEMBERTON (*15*) reports that in a plane from the Philippines the remains were found of a specimen of *Leucopholis irrorata* Chevr., a polyphagous beetle well known in the latter isles as a veritable scourge of agriculture. In fact, its larvae eat into the roots of sugarcane (*Saccharum officinarum*), maize (*Zea mays*), rice (*Oryza sativa*), Guinea grass (*Panicum maximum*), mango (*Mangifera indica*), sandal (*Sandoricum indicum*), *Canna* spp., pineapple (*Ananas sativus*), water melon (*Citrullus vulgaris*) and peas (*Pisum sativum*), while the adult insects feed on the leaves of mango, Siamese senna (*Cassia siamea*), mabolo (*Diospyros discolor*), purple mombin (*Spondias purpurea*), sandal, jambolan plum (*Eugenia jambolana*),

tamarind (*Tamarindus indica*), Assyrian plum (*Cordia myxa*), grey wood of Seroat (*Streblus asper*) ; and it is probable that this already long list of plants which form a source of food for this Melolonthin will become still longer.

WELCH (*27*) gives the results of inspection of planes arriving at Miami, Florida, from Mexico, Central and South America, Puerto Rico and Trinidad during the course of 1938. On 187 planes there were found in all 653 Arthropoda : 2 living Araneida and 651 insects (Orthoptera, Hemiptera, Lepidoptera, Coleoptera, Hymenoptera and Diptera) ; of these insects, 165 were caught in the live state. This group included, *inter alia*, the lesser corn stalk borer (*Elasmopalpus lignosellus* Zeller), the fall armyworm (*Laphygma frugiperda* Smith et Abbott) and the Indian meal moth (*Plodia interpunctella* Hbn.) as well as the grapefruit fly (*Drosophila melanogaster* Meig.), *Dros. repleta* Wollaston, the spotted root fly (*Euxesta notata* Wied.), etc.

Another North American source (*19*) indicates that round about 1939 was found an exotic Pyralid, the Indian pod borer (*Maruca testulalis* Gey.), already known in India and elsewhere as dangerous to many cultivated plants.

In a work published in November, 1939 WHITFIELD (*28*) also speaks of the insects found on the commercial aircraft arriving at Khartoum airport, Anglo-Egyptian Sudan, where he resided. From July, 1935 to August, 1938 over 2,000 planes were inspected and approximately 3,000 insects belonging to 146 species were collected. By way of example, mention will be limited to a few of agricultural importance : *Sinoxylon ruficorne* Fhs., *Pachymerus pallidus* Ol., *Lema melanopa* L., *Podagrica puncticollis* Wse. among the Coleoptera ; *Agrotis ypsilon* Rott., *Hippotion celerio* L., *Plutella maculipennis* Curt. among the Lepidoptera ; *Lygaeus pandurus* Scop. among the Hemiptera, etc.

GLICK (*6*) has carried out investigations over a five-year period in Louisiana lnd Mexico on the aerial distribution of insects, spiders and mites*, using for the collaection of material special traps attached to the wings of the different types of planes which flew at altitudes varying from 20 to 15,000 feet. He reports that frequently during these atmospheric researches, numerous live insects, among which were also found species known as agricultural pests such as the Lepidoptera *Alabama argillacea* Hbn., *Heliothis obsoleta* Fabr., *Laphygma frugiperda* Smith et Abbott, were seen to come out of the cockpit of the plane or else penetrate into it when the airplane flew at an altitude of 2,000-4,000 feet, as in the case of the three-cornered alfalfa hopper (*Stictocephala festina* Say) and the chinch bug (*Blissus leucopterus* Say). Against the affirmations of GLICK, there is the opinion expressed by SYMES (*20*), WHITFIELD (*28*) and the captains and pilots of aircraft question-

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* Those who wish to gather documentary evidence of the state of researches and investigations relative to the atmospheric fauna and flora as well as their practical importance, may advantageously consult the work of the author cited above, also that of WHITFIELD (*28*) and the report of the Committee on Apparatus in Aerobiology of the National Research Council, Washington, D. C. (*2*). Each of these three publications is accompanied by an extensive bibliography.

ed by the latter on the matter : namely, that it is extremely difficult if not impossible, under normal conditions and with modern air vehicles, for insects to enter a plane during flight. According to them, the insects make their entry while the planes are at rest.

In a brief note by MACKIE (*10*) inspired by the bibliographical analysis of the work of WHITFIELD already cited, mention is made of the possible carriage in aircraft of the ' cotton bollworm ' * and the Japanese beetle (*Popillia japonica* Newm.).

In discussing the investigations on this latter insect, carried out in Bermuda during the quarantine period June 1-August 31, 1939, WATERSTON (*26*) pointed out, *inter alia*, that the danger of introducing the beetle from the United States, by aircraft, appeared much greater, in a certain sense, than in the case of a steamer owing to the shorter duration of the voyage. He also recalls that on July 26, the master of the ' Bermuda Clipper ' wirelessed the Bermuda Department of Agriculture that a live Japanese beetle had been discovered in the plane en route for those Islands. Subsequent search made on arrival at Darrell's Island led to finding a second live beetle on top of the wing. WATERSTON adds that in view of the physical impossibility of the insect to find a sufficient foothold on the outside of the plane, it may be taken that this specimen escaped from the forward at the time of mooring.

* * *

These very recent examples given above prove sufficiently the actual danger which air transport presents for the spread of plant parasites †.

Whether carried unknowingly by man on board a plane, with plants, parts of plants, seed, vegetables, fruit, flowers, with receptacles and relative packing material, or with the luggage and even on the clothes of the travellers, or whether they penetrate directly as clandestine passengers into the plane at rest in the airport or sea-plane base of departure or arrival, a number of the most varied crop parasites, possibly including very injurious or even dangerous species, find themselves in a position to be transferred alive and healthy, with extreme facility and within a few hours, even without food or moisture, very appreciable distances from the place of origin. Consequently, in face of air transport, the Sahara Desert and the oceans no longer function as natural barriers.

It should also be taken into account that taking off and landing may be effected outside the proper air-field. It is not unusual, in fact, for planes to utilize

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* MACKIE undoubtedly here wished to refer to the pink cotton bollworm (*Platyedra gossypiella* Saund.).

† It may be added that air traffic can also serve for the spread of infectious diseases of man and domestic animals through the transport of persons or animals in the incubation stage, and also through that of insect carriers of these diseases. See, *inter alia*, the monograph of WHITFIELD (*28*) which summarizes with great care the information and data acquired up to 1939 on this subject, from the medical and veterinary standpoint, and assembles and coordinates the already very copious bibliography concerned.

especially in war-time, make-shift fields or improvised runways which, as sometimes in the case of the air-ports, are situated in the heart or the immediate neighbourhood of densely cultivated, high yielding fields, which may thus be easily and rapidly invaded by unexpected and undesirable guests.

It cannot be excluded *a priori* that the plant or animal species which, although frequent and practically inoffensive in the region from which they originate, may become harmful and even dangerous in the region to where they arrive if it offers them new and favourable environmental conditions.

Nor is there anything extraordinary in supposing that some serious diseases of important crop plants can be introduced by the air transport of insect vectors into a country where, however, the most rigorous measures are in force against the importation and transit of these plants and parts of same, precisely with a view to preventing the introduction of these diseases.

Accordingly, since this risk of spreading pests and diseases exists, everything materially possible should be done to avert it, diminish it or at least delay as long as possible the eventual practical consequences.

It is evident that the first and infallible condition to attain this end is the application of an uninterrupted and absolutely strict phytosanitary control of importation by air of plants, parts of plants, etc.

It is understandable that in normal times this measure could be omitted in the countries where usually the importation of all products of plant origin by air is strictly prohibited.

It may be asked, however, whether these same countries, during the present war, are in a position to protect themselves fully against the non-observance of this interdiction, considering the necessarily abnormal conditions under which air movement is effected in their respective territories. On the other hand, it is to be doubted, at least immediately following the end of the war, that is to say, before the usual communication routes are restored to normal, whether they can easily do without air transport for the indispensable and urgent supplying of certain products from outside the frontier.

After all, account has to be taken of the unexpected. The improbable of today may become the reality of to-morrow.

In the countries where the phytosanitary control of planes is already in force, there is every advantage in ever more improving and intensifying it.

Finally, it is indispensable and even urgent to introduce this measure of caution and protection in the different countries — which would be the majority, according to what is known of their legislation (7) — where this special control does not seem to be in force.

Once the phytosanitary control of airplanes is included in the ordinary duties of each well organized plant protection service, the technicians who will be in charge will certainly not fail to note the date of observation, place of origin of the airplane, scientific and common name, stage of development, individual state (alive or dead), etc., of all organisms, without exception, found inside or outside the plane.

It would be prudent to register also the organisms which, even after careful

examination, are not fully identified, since there is nothing to prevent some of them being possible plant pests.

Moreover, it would be advisable for the lists containing the results of the observations made on this subject always to be made public, and, if possible, periodically. It is important to know them for the immediate purpose of taking protective and control measures, as well as regards the import and export of agricultural products, not only for the country where the organism was found, but also for the country whence the inspected airplane comes, and for those which lie within its normal route.

This could sometimes be a means of ascertaining the effective presence of a specific parasite of crops in a locality where formerly its possible presence was not even suspected.

Again, an occasional discovery on board a plane may be the preliminary announcement of the more or less close possibility of the introduction of a given parasite into a region where it is still unknown.

With a view to being of assistance to the different countries, the International Institute of Agriculture is fully prepared to centralize the lists which the government authorities, competent organizations and technicians may wish to transmit, and to give them the widest and most rapid publicity in the *International Bulletin of Plant Protection* and the *Moniteur international de la Protection des Plantes*.

* * *

It is evident, from the practical standpoint, that it is not sufficient to know what and how many organisms an airplane can spread throughout the world and from which country they originate.

It is also particularly necessary to anticipate the damage these living organisms may cause to the crops with which air traffic puts them into more or less immediate contact.

In order to attain this end, it will be necessary to provide for the disinfection of the airplanes and all they contain or transport.

For several years already, for this purpose, control processes and material havs been employed, particularly against insects and other Arthropoda.

If, on the contrary, it is a question of recognized or suspected plant parasites on the plants, parts of plants and agricultural products in general which could not practically be disinfected on board the plane, it will be necessary to unload these products, taking every possible care, and treat them appropriately in special premises located preferably at the air-port or the sea-plane base, with disinfectants of recognized efficacy. If necessary, recourse will also be had to the quarantine, return or destruction of the goods without delay, carefully avoiding all shifting of the infected products from one place to another.

Symes (20) states that disinfection of the air-plane may be effected immediately before departure from the air-port, or better still, directly after departure.

According to this investigator, the possibility of the plane with all its load, on arrival at the next port of call, being again disinfected, is not to be excluded

The same author recommends the use of an insecticidal mixture for spraying composed as follows : —

Pyrethrum extract, standard concentrated	1 part
Good quality liquid white paraffin	16 parts
Carbon tetrachloride	68 »

At the dose of 20 cc. per 1000 cubic ft., this mixture kills all mosquitos in 5 minutes. With stronger doses and longer duration of action, it is effective against insects such as house-flies. SYMES adds that to control other insects and certain mites, the strength of the pyrethrum extract would have to be increased very much more than that which is not injurious to man, or else employ some other entirely different substance, as active perhaps as hydrocyanic acid gas.

For the application of the insecticide he recommends, the choice of the author falls on the sprayer made by the British Aerograph Company.

WELCH (*27*) relates that the air-plane is sprayed in the air half an hour before landing at Miami, Florida and at the other ports of call en route, by means of a hand atomizer loaded with a mixture of 1 part standardized pyrethrum extract, containing 2 grams pyrethrin per 100 cc., 4 parts highly refined mineral oil having a relatively high flash point. An endeavour is made to spray thoroughly all the compartments of the plane, by employing 5 to 10 cc. of the insecticide per 1000 cubic ft. Despite all the precautions taken, however, live insects are still found after treatment.

MACKIE (*9*), however, affirms that there are at least two efficient aqueous base pyrethrum insecticides on the market, the names of which he does not give, which, suitably diluted, will ensure the death of moquitoes and other flying insects in aircraft within a few minutes of application. He adds that pyrethrum preparations are being used in all parts of the world by aircraft companies and by the sanitary authorities of air-ports, and that we may safely say that science has provided the means of abolishing the danger of insect transmission by aircraft, and it only remains for international authorities to insist on these measures being carried out.

ROSS (*16*) who aims only at the destruction, in the planes, of mosquitoes vectors of yellow fever, describes the apparatus tried out for this purpose : the Larmuth ejector (old and new type), the ' Phantomyst ', as well as the insecticides employed (' Deskito ', soluble in water ; ' Aircraft Pyagra ', preparation composed of 1 part pyrethrum extract and 4 parts carbon tetrachloride), sprayed both during flight and when the plane is on the ground.

The results of the experiments carried out showed that with the use of the Larmuth automatic ejector, filled with Aircraft Pyagra, the air-plane can be completely freed from mosquitoes in 10 minutes and perhaps even in 5. On the other hand, according to ROSS, treatment effected with a hand atomizer during flight is found to be ineffective.

On conclusion of his study, this author writes textually : — ' Some correspondents consider that the measures taken on the planes should aim at the destruc-

tion not only of mosquitoes but of all live insects, including those harmful to agriculture. This would be equivalent practically to delaying the question until we succeeded in employing agents of general application like cyanide, or putting it off until another more sure means is found.'

At Khartoum, Anglo-Egyptian Sudan, disinfection was effected on the arrival of planes at this air-port from the first. In some cases, the planes which were disinfected had already been treated during flight. WHITFIELD (*28*), however, states that hand-pump treatment and a pyrethrum base insecticide do not give complete satisfaction.

In his opinion, the control measures against insects in transport aircraft should be carried out half an hour before the planes leave the air-port and that they should be repeated half an hour before the next landing. It is the task of the entomologist, the chemist and the engineer to provide for a suitable system and a chemical which ensures 100 per cent. results within a given time. A system of power spraying or fumigation should be built into all transport planes, possibly incorporated with an air duct system and operated by the captain or pilot. Military and private aircraft, on the contrary, should be treated on the ground in a fumigation chamber or else by means of a portable spraying or fumigating machine, similar n its essential parts to that which should be installed in the transport aircraft.

i For his part, WATERSTON (*26*) said, in January 1940, that as precautionary measure against the introduction of the Japanese beetle (*Popillia japonica* Newm.) into Bermuda, the Pan American Airways Company had proceeded the previous year to have all parts of the interior of the plane sprayed with an insecticide immediately before embarkation of the passengers ; the plane was then left completely closed for 10 minutes. Immediately before arrival at Bermuda, the air-plane was again subjected to treatment. A liquid composed of 1 ½ parts carbon tetratchloride, 2 3/4 parts Sprayene Oil and 1 part ' Pyrocide Twenty ' (a commercial preparation containing 2 per cent. pyrethrin in kerosene) was employed. This mixture was distributed by means of an ordinary hand spray gun ; 10 cc. of the mixture were used for every 1000 cubic ft.

The same WATERSTON adds that experiments carried out for the Bermuda Department of Agriculture by Dr Albert HARTZELL of the Boyce Thompson Institute for Plant Research at Yonkers, New York, caused some doubt to be raised as to the efficacy of the method indicated above as a lethal control measure against this dreaded beetle. Dr HARTZELL used a preparation of pyrethrum containing 2 grams of pyrethrin per 100 cc. and 4 parts of highly refined mineral oil (' Deo-Base '). Experiments were effected under conditions resembling those in a plane. Two lots of 50 beetles each were sprayed in a chamber (modified Poet-Grady chamber) with a capacity of 108 cubic ft. using 6 cc. of the insecticide atomized by means of No. 15 De Vilbiss nozzle at 12 lb. pressure. He obtained a complete knockdown in 10 minutes, but the actual mortality verified was only 20 and 28 per cent. in the two lots, although the volume of the insecticide employed was ten times that employed by the Pan American Airways. Consequently, it appears, concludes WATERSTON, that it will be necessary to adopt a higher concentration of pyrethrin

or a greater volume of insecticide to prevent live beetles being transported into Bermuda.

Under the present situation, while the war continues, it is not easy to ascer tain whether, precisely during the last few years, it has been possible to register the improvements and progress made as regards the control processes and material in question.

From this viewpoint also, it goes without saying that the most liberal hospitality will be given in the two foresaid periodicals of the International Institute of Agriculture to the suggestions, proposals for examination in common, plans to be adopted in co-operation, the definite results of research work and experiments, etc, which the competent organizations and technicians desire to bring as soon as possible to the knowledge of the international circles concerned.

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